November 11, 2024

Mr. Tanner Kirksey
Associate Attorney
Keane Law LLC
7711 Bonhomme Ave, Ste 600
St. Louis, MO 63105

Re: **Francis v Wausau Homes Incorporated, et al. – Supplemental Report**
Case No: 5:23-cv-06019

Dear Mr. Kirksey:

At your request, Christopher Wilkens, P.E. of J.S. Held LLC (J.S. Held) conducted a supplemental evaluation pertaining to the construction of the single-family residential structure located at 31328 Lace Ave., Fairfax, Missouri, 64446. This is a supplemental report, to be used in conjunction with the original report dated January 12, 2022.

BACKGROUND

Previously, in November of 2021 through January 2022, we conducted an evaluation of reported issues relating to suspected construction issues on behalf of Zurich North America, and issued a report of findings dated January 12, 2022. The stage of construction, both then and now, was characterized by generally completed structural framing that was predominantly dried in via the installation of doors, windows, exterior house wrap, and a shingle roof covering.

PURPOSE

The purpose of this supplemental evaluation was to identify any additional damage or issues stemming from deficient construction that were not visually apparent at the time of the previous evaluation, to identify conceptual scopes of repair that would be required for the damage or issues, to identify whether provided cost estimates for repairs adequately addressed the scope of repairs needed, and to identify whether the deficient construction issues constituted a violation of building codes.

SITE INSPECTION

Christopher Wilkens, P.E. of J.S. Held conducted a site inspection at the residence on October 4, 2024. A selection of photographs taken during the site inspection, referenced within this report, are included in **Appendix A**.

OBSERVATIONS AND ANALYSIS

Item 7: Settlement Issues

The southwest corner of the garage floor area exhibited a sink hole type of pit within the subgrade, where the rigid foam insulation that had been placed atop the subgrade was sunken downward into the hole. (**Photos 1-3**).

At the time of the prior evaluation in 2021, the southwest corner of the garage did not visibly exhibit the sunken materials that were visible at current time. The subgrade soils where the hole existed were immediately adjacent to the full height basement foundation wall forming the southeast corner of the basement, and therefore, at an area that had necessarily received full height backfill from the elevation

at the base of the basement wall to the elevation of the garage floor. The hole was therefore an indication that the backfill soils were not properly installed in that area, and subsequently underwent consolidation that resulted in lowering top elevation of the fill. This led to the formation of void space between the top of the fill and the underside of the rigid foam slab insulation panels. **Therefore, it was concluded that the sink hole was caused by insufficient preparation of the subgrades within the garage area.**

A conceptual repair scope for the sink hole issue in the garage would entail the removal and replacement of the fill soils using soil materials and compaction parameters outlined by a design professional.

The full-height basement foundation walls (at the west, north, and east sides of the basement) each exhibited concrete cracks located at the approximate mid-lengths of each wall, and that meandered in a generally vertical alignment from the top to bottom of the walls. The widths of the cracks were generally in the range of about 1/32 inches, or about 0.03 inch, in width. The crack on the east foundation wall, however, was narrower toward the base of the wall and widened toward the top of the wall, ranging from hairline to approximately 0.04-inch width. (**Photos 4-8**).

Shrinkage cracks in concrete foundation walls commonly manifest as vertical cracks near the mid-points of a wall length. Shrinkage cracks alone are expected and accepted as normal concrete behavior upon curing. However, normal shrinkage cracks are generally limited to hairline width. American Concrete Institute guidelines state that reasonable crack widths for reinforced concrete under service loads exposed to humidity or soil is 0.012 inches, and for concrete exposed to dry air, 0.016 inches. Approximately 1/64 inches in both cases. Here, the cracks were approximately double to triple of those widths. Larger crack widths can indicate additional issues causing distress beyond normal and accepted concrete shrinkage. Tapered width cracks, as seen at the east wall, are an indication of in-plane rotational and/or shear stress in the wall that can be caused by differential settlements of the foundation into bearing soils. **Therefore, it was concluded that the formation of the concrete wall cracks to widths beyond typical, hairline cracking, was caused by an insufficiency of the foundation or footing construction and/or the bearing soils preparation that led to settlement strains in the concrete.**

A conceptual repair scope to reinstate water tightness and continuity at the cracks would entail the installation of patching materials into the cracks. However, it should be noted that continued settlement distresses may be ongoing depending on the severity of bearing soil or footing limitations allowing for movements. A repair scope intended to prevent possible continued movements and crack growth would entail reinforcement of the foundation such as with a retrofit pier system. In the absence of such reinforcement repair, and in the case of continued foundation movements after the completion of the construction, interior finishes would be at risk of future cracking and/or separation damage.

Two repair estimates were provided for review pertaining to the foundation and flatwork components. The estimate by Ideal Concrete Construction included line items accounting for an apparent regrading ("dig out") of the soil subgrades (surface preparation) at the basement and garage areas, along with materials for placement of concrete slabs with foam insulation and steel rebar. However, it did not include line items for removal and reinstallation of the welded wire fabric concrete reinforcements, nor the radiant heat tubing, nor for removal and re-installation of fill soils in the garage where the sink hold had occurred. The estimate by Thrasher Foundation Repair included a scope to fully reinforce the extents of the foundation with retrofit piers, which was an appropriate scope for bracing the foundation and prevention of continued movements and associated distresses, but it did not include scope to patch existing foundation wall cracks. Additionally, neither of the estimates addressed the concrete foundation issues identified in the original evaluation, which included the jackhammered stem walls at the overhead

garage door openings, spalled adjacent stem walls, and the misalignment of the garage foundation walls with the exterior stud wall framing.

Collectively, these estimates accounted for some, but not all, of the repair scope that would be necessary to address deficiencies and damage pertaining to the concrete foundations and soils.

Item 8: Roofing Envelope Issues

At the southwest and northwest roof corners, the OSB roof sheathing and the adjacent roof joist lumber and rim joist lumber exhibited dark discoloration from moisture exposures emanated on the backsides of the rim joists. (**Photos 9-12**).

Shingle roof installations utilize metal flashing drip edges at the boundary edges (eave and rake edges) to direct runoff water downward and outward from the roof plane and fascia. The presence of dark discolorations on the wood framing from moisture exposure was an indication that water had migrated through the roof envelope near the location of the drip edges, and therefore indicated a likely incompatibility with the drip edge to underlayment interface, and/or an absence or other issue involving drip edge or underlayment. Such water damage was observed at both the north and south roof eave edges. **Therefore, it was concluded that the water migration and damage was caused by a deficient installation of the shingle roofing system.**

A conceptual repair scope for the roofing items would entail removal and replacement of water damaged rim joists and OSB roof sheathing, scabbing/sistering of reinforcement wood onto water damaged joist overhangs, and reinstallation of the shingle roofing system (including drip edge and underlayment) along the edges and/or the entirety of the roof to properly install and integrate underlayment and drip edge components. However, destructive inspection such as spot removal of shingles would be required to determine the full nature and extent of the roofing installation issues, and the scope of the necessary repairs relating to the roofing installation.

A bid proposal by Jason Brown Roofing was provided for review pertaining to the roofing issues. The proposal included line items accounting for removal of the roofing, replacement of the underlayment, and installation of new roofing. However, it was absent line items to account for the replacement and/or reinforcement of water damaged framing members such as the rim joists, OSB roof sheathing, and roof eave joists.

Therefore, the Jason Brown Roofing estimate accounted for some, but not all, of the repair scope that would be necessary to address construction deficiencies and damage pertaining to the roof envelope.

Item 9: Exterior Wall Envelope Issues

Around all exterior elevations of the residence, the synthetic house-wrap WRB (weather resisting barrier) exhibited varying conditions of tattering, fraying, and detachment. Additionally, at boundary edges of the WRB such as the overhead door openings of the garage and at varying bases or edges of exterior wall framing, the exterior OSB wall sheathing was exposed to the exterior and exhibited dark discoloration and softened wood due to long-term moisture exposure. (**Photos 13-19**).

WRB is an integral component of exterior wall envelopes that is intended to be concealed by the permanent exterior cladding materials, and is not intended to protect the structure from the exterior elements on its own over a long period of time. The observed conditions represented a collective decay of the material due to long-term direct exposure to the exterior environment. This decay led to direct water and sunlight exposure to localized areas of OSB wall sheathing, which in turn caused moisture and UV damage to areas of OSB sheathing. **Therefore, it was concluded that the exterior WRB and localized**

areas of OSB exterior wall sheathing were damaged due to long-term exposure from incomplete exterior wall cladding installation.

A conceptual scope of repair for the exterior wall damage would entail removal and replacement of all WRB, and select removal and replacement of damaged OSB sheathing panels, followed by the installation of a permanent exterior cladding to appropriately conceal the WRB system. However, the destructive removal of the existing WRB would be required to determine the full extent of OSB damage and replacement scope.

The bid proposal by Jason Brown Roofing included a line item for the installation of vinyl siding and trim, which would account for the permanent cladding installation to properly conceal the WRB system. However, it did not account for removal and replacement of the WRB and exterior OSB sheathing damage as noted above.

Therefore, the Jason Brown Roofing estimate accounted for some, but not all, of the repair scope that would be necessary to address construction deficiencies and damage pertaining to the exterior wall envelope.

BUILDING CODES

To current understanding, neither the State of Missouri nor Atchison County, Missouri, currently (or at the time of construction) adopt or enforce building codes. The residence was understood to be within an unincorporated area of Atchison County; not within the limits of any cities or towns that may have adopted building codes. As such, there were no jurisdiction-specific building codes that governed the construction of the residence by governmental statute.

However, the Missouri Department of Commerce and Insurance, via the Missouri Board for Architects, Professional Engineers, Professional Land Surveyors, and Professional Landscape Architects, requires that:

> "*For building design, the board shall use, in the absence of any local building code, the 2018 edition of the International Building Code, as the evaluation criteria in determining the appropriate conduct for any professional licensed or regulated by this chapter…*"

Therefore, the engineering design of the subject residence would have required adherence with the 2018 International Building Code (IBC). The 2018 IBC, by reference, incorporates the 2018 International Residential Code (IRC) for use pertaining to detached, one-family dwellings.

The 2018 IBC and IRC are well-recognized authorities for the design and construction of structures. Of note, the 2018 IRC states:

> "*The provisions of this code shall apply to the construction, alteration, movement, enlargement, replacement, repair … of detached one- and two-family dwellings…*" (R101.2)
>
> "*It shall be unlawful for any person, firm or corporation to erect, construct, alter, extend, repair … any building, structure or equipment regulated by this code, or cause the same to be done, in conflict with or in violation of any of the provisions on this code.*" (R113.1)

The 2018 IRC establishes "*minimum requirements to safeguard the public safety, health and general welfare…*" (R101.3). It represents, by industry consensus, established provisions, standards, and guidelines for the design and construction of buildings such as the subject residence. As such, the noted construction deficiencies in this evaluation were weighed against the requirements given in the 2018 IRC, as follows:

Insufficient subgrade depth at basement floor, allowing only a 3-inch slab at eastern wall instead of 4-inch slab thickness.

This condition violated 2018 IRC, Section R506, Concrete Floors (On Ground), R506.1 General:

> *"Floors shall be a minimum of 3.5 inches thick."*

Additionally, it violated the plan set which denoted a 4-inch concrete slab floor in Sections C-C and E-E on Sheet A4.

Sinkhole soil settlement in garage.

This condition violated 2018 IRC, Section R506 – Concrete Floors (On Ground)., R506.2.1 Fill:

> *"Fill material shall be free of vegetation and foreign material. The fill shall be compacted to ensure uniform support of the slab, and except where approved, the fill depths shall not exceed 24 inches for clean sand or gravel and 8 inches for earth."*

Cracks in basement foundation walls exacerbated by settlement.

Improper foundation construction or soil preparation violate 2018 IRC, Chapter 4 Foundations, Section R401.2 Requirements:

> *"Foundation construction shall be capable of accommodating all loads in accordance with Section R301 and of transmitting the resulting loads to the supporting soil. Fill soils that support footings and foundations shall be designed, installed and tested in accordance with accepted engineering practice."*

Roofing Installation – Deficient drip edge and/or underlayment installation or interfacing.

Deficient installation or interface of drip edge with the underlayment would violate 2018 IRC, Chapter 9 Roof Assemblies, Section R905.2.8.5 Drip edge:

> *"A drip edge shall be provided at eaves and rake edges of shingle roofs"*
>
> *"Underlayment shall be installed over the drip edge along eaves and under the drip edge along rake edges."*

Certain other deficient installation of the underlayment would violate 2018 IRC, Chapter 9 Roof Assemblies, Table R905.1.1, which specifies installation parameters for underlayment as a function of the roof slope, and/or other provisions of Section 905.1.1 Underlayment. Destructive testing would be needed to know whether underlayment was installed per code or not.

Wall Envelope – Damage due to weathering from long-term exposure.

The long-term exposure of the WRB violated 2018 IRC, Chapter 7 Wall Covering, Section R703.2 Water-resistive barrier:

> *"Other approved materials shall be installed in accordance with the water-resistive barrier manufacturer's installation instructions."*

The Typar Building Wrap manufacturer literature indicated that it withstands UV (sunlight) exposure for up to 6 months. Therefore, the WRB should have been concealed by permanent exterior wall cladding before that time in accordance with manufacturer requirements.

REVIEWED DOCUMENTATION

The following documents were reviewed as part of this supplemental evaluation:

1. *Control of Cracking in Concrete Structures*. American Concrete Institute. ACI 224R-01.
2. Cost estimate # 1623, dated 3/13/2022, by Ideal Concrete Construction, LLC.
3. Cost estimate by Thrasher Foundation Repair, dated 1/18/2024.
4. Bid Proposal by Jason Brown Roofing, LLC, dated 4/8/2022.
5. Missouri Code of State Regulations (https://www.sos.mo.gov/adrules/csr/csr.asp)
6. Atchison County Development Corporation (https://atchisoncounty.org/)
7. 2018 International Building Code, International Code Counsil, Inc.
8. 2018 International Residential Code, International Code Counsil, Inc.
9. Typar Building Warp Sell Sheet, August 2019 (https://www.typar.com/assets/downloads/typar-buildingwrap-sellsheet.pdf)
10. Transcripts from depositions of Cole and Christina Francis, dated September 27, 2024.

CLOSING

The opinions and conclusions in this report have been formulated to a reasonable degree of engineering certainty and based on the information obtained and/or provided, as well as my training, knowledge, and experience. If additional information becomes available, I reserve the right to review additional information that may become available, and if warranted, to revise the opinions presented in this report.

Respectfully,

J.S. Held LLC
MO COA No. 2018010517 (Expiration date 12/31/2025)

This item has been electronically signed and sealed by Christopher Wilkens, P.E. on November 11, 2024 using a Digital Signature. Printed copies of this document are not considered signed and sealed, and the signature must be verified on any electronic copies.

Chris Wilkens, P.E.
Senior Vice President - Senior Engineer
MO License No. 2011026226 (Expiration date 12/31/2025)

Encl. Appendix A: Photographs

APPENDIX A

Photographs

Photo 1: View of the southwest corner of the garage, showing the "sink hole" area within the subgrade.

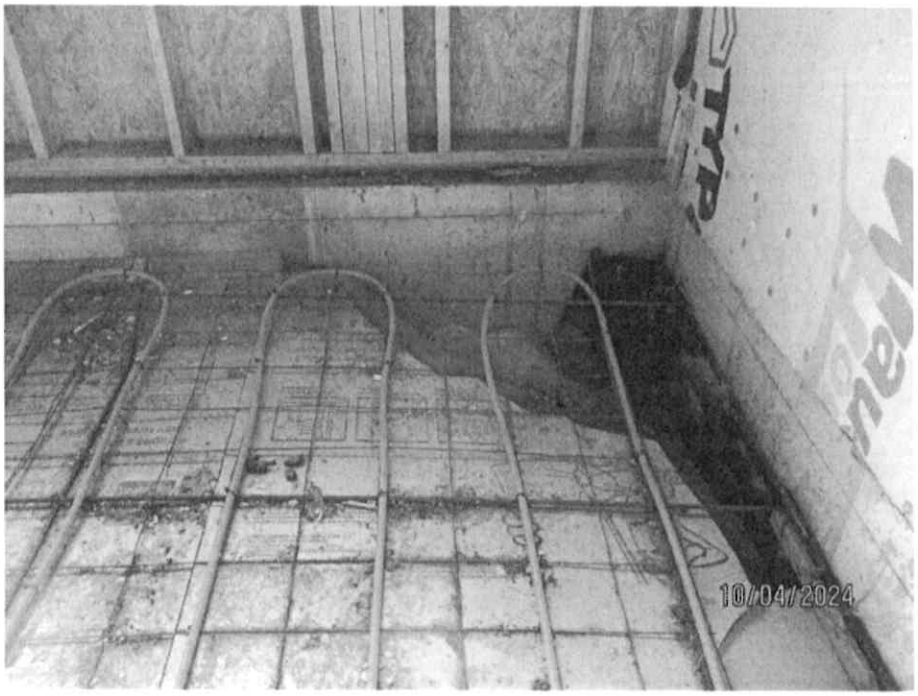

Photo 2: View of the "sink hole" area at the southwest corner of garage; view from north side.

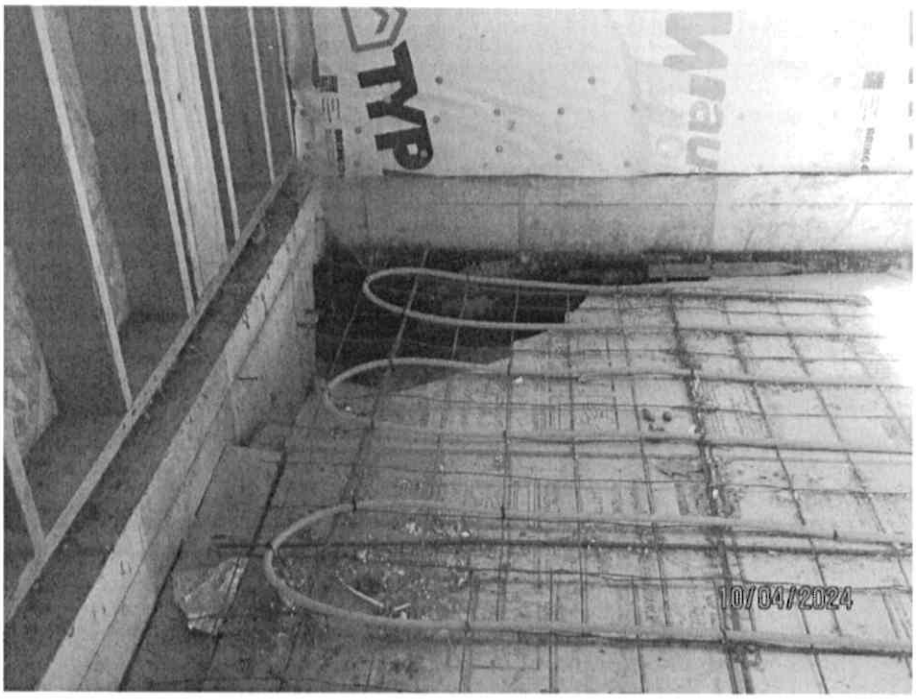

Photo 3: View of the "sink hole" area at the southwest corner of garage; view from east side.

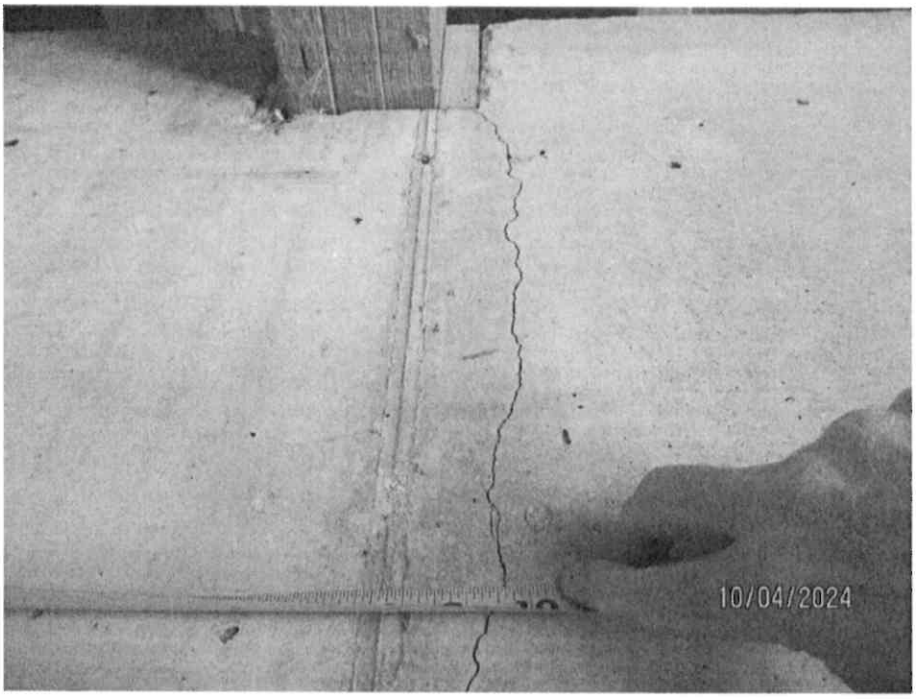

Photo 4: View of foundation wall crack at the east basement foundation wall. See next photos.

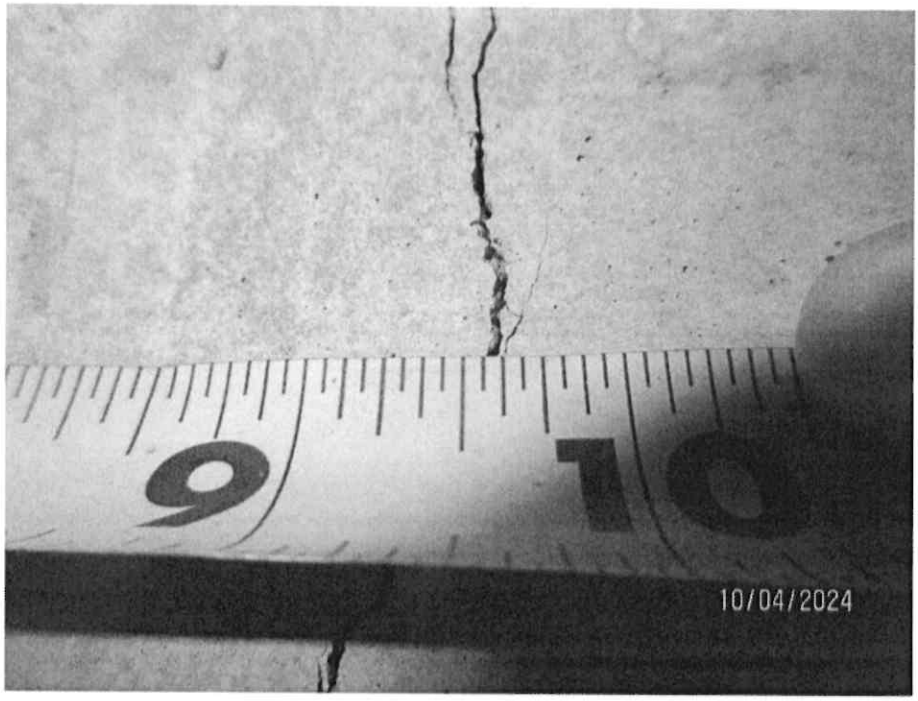

Photo 5: View of east foundation wall crack showing approximately a 0.04-inch (3/64 inch) crack width near the top of the wall.

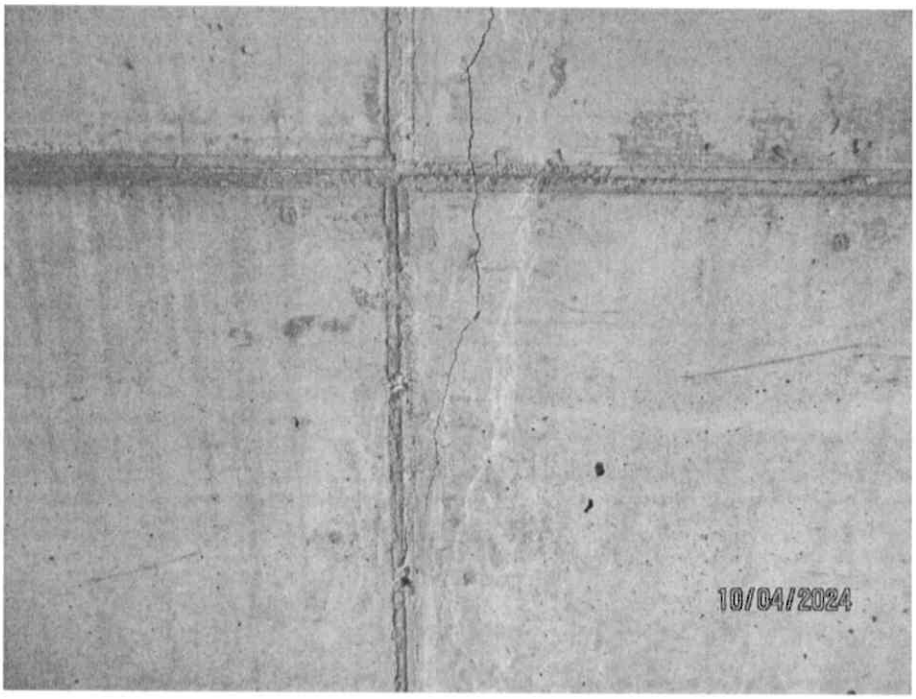

Photo 6: View of crack narrowing in width toward the lower half of the east foundation wall.

Photo 7: View of foundation wall crack at the north basement foundation wall. See next photo.

Photo 8: View of north foundation wall crack showing approximately 0.03-inch crack width (1/32 inch).

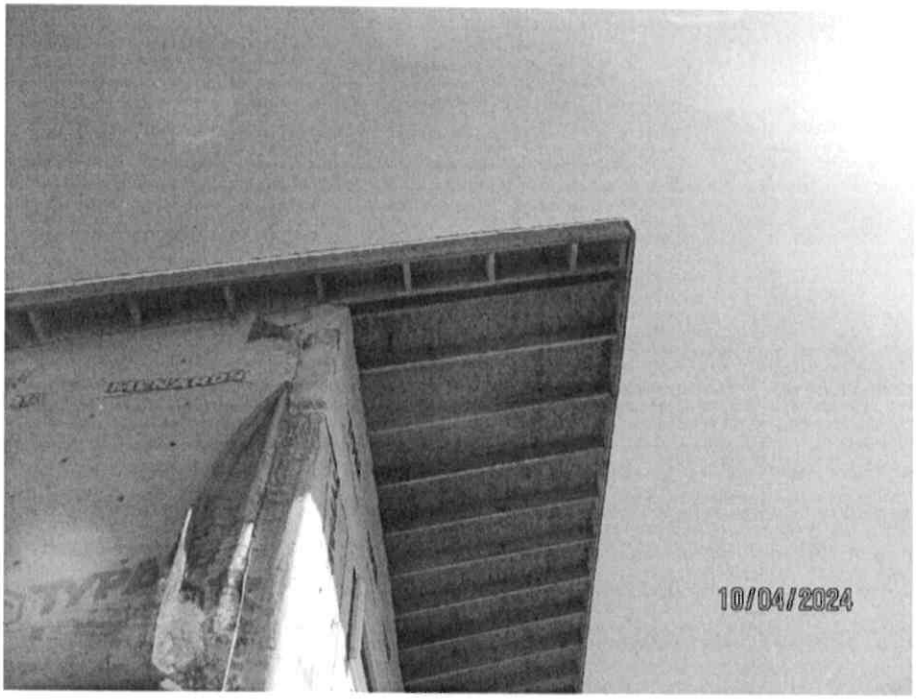

Photo 9: View of the southwest corner of the roof. See next photo.

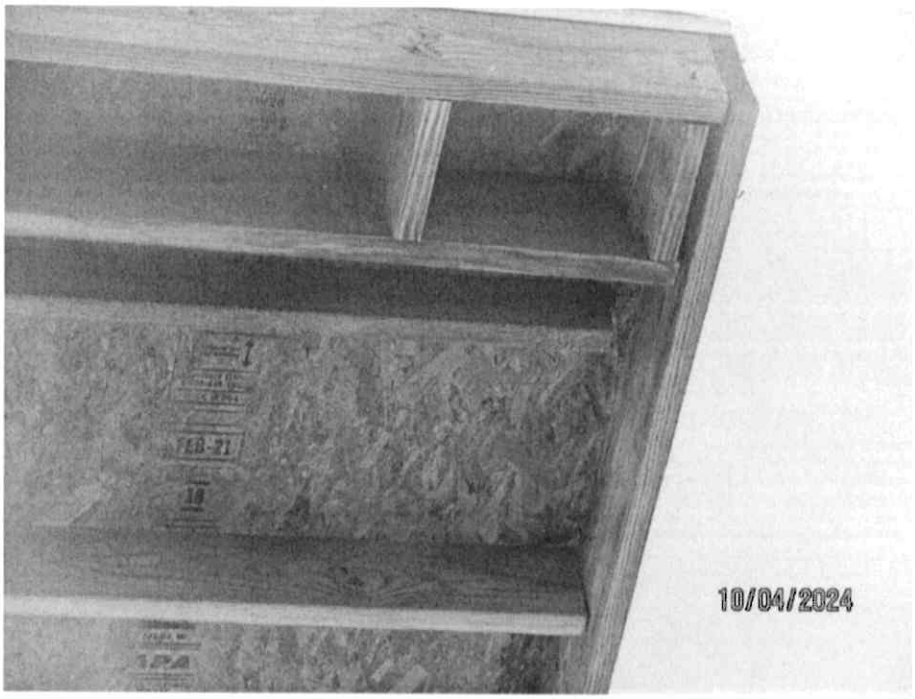

Photo 10: View of southwest corner of roof framing showing dark wood discoloration at OSB roof sheathing, joists, and rim joist.

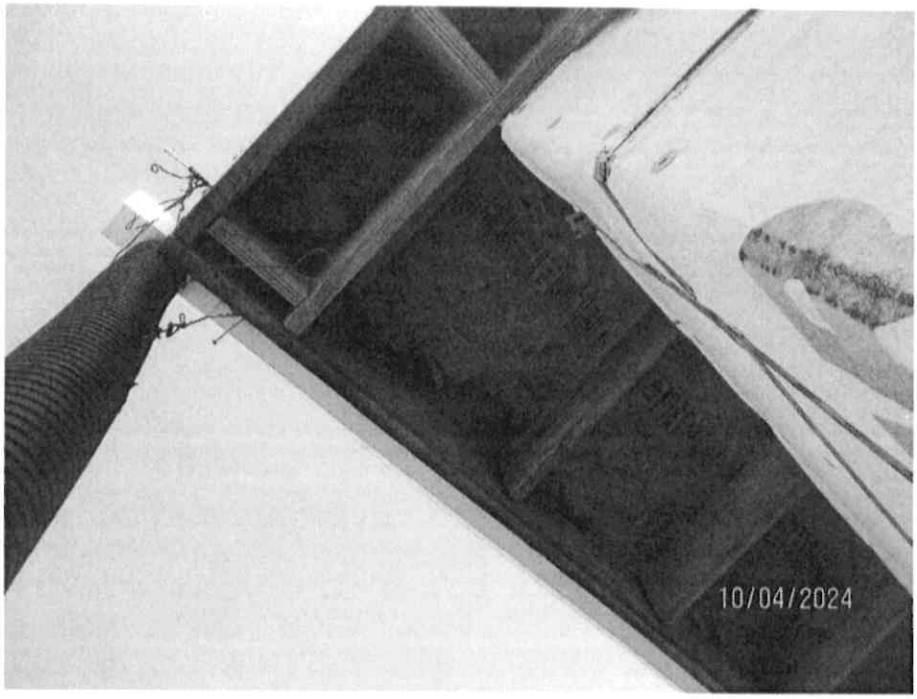

Photo 11: View of the northwest corner of the roof framing. See next photo.

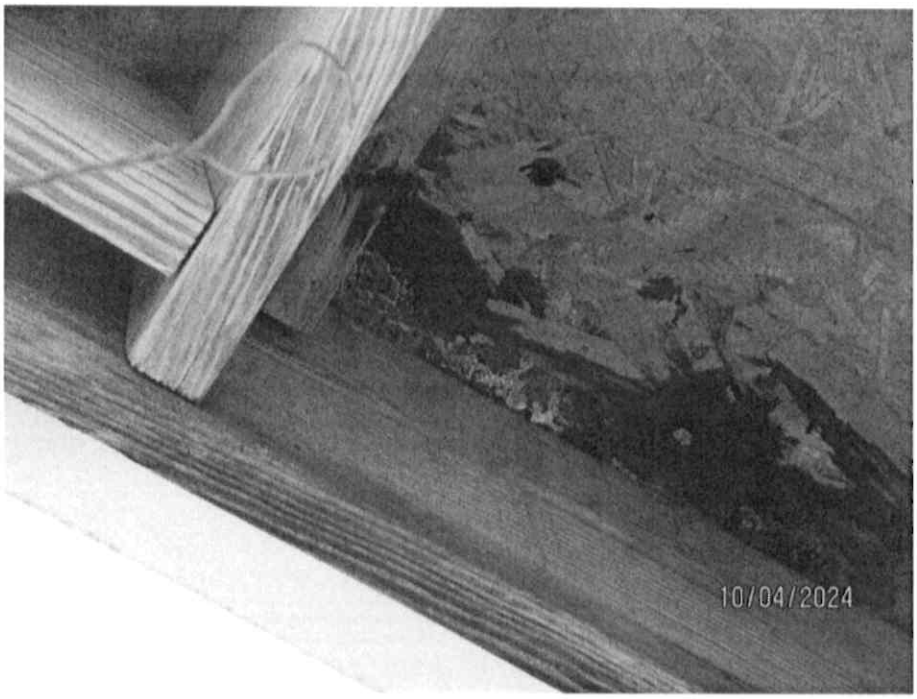

Photo 12: View of northwest corner of roof framing showing dark wood discoloration at OSB roof sheathing, joists, and rim joist.

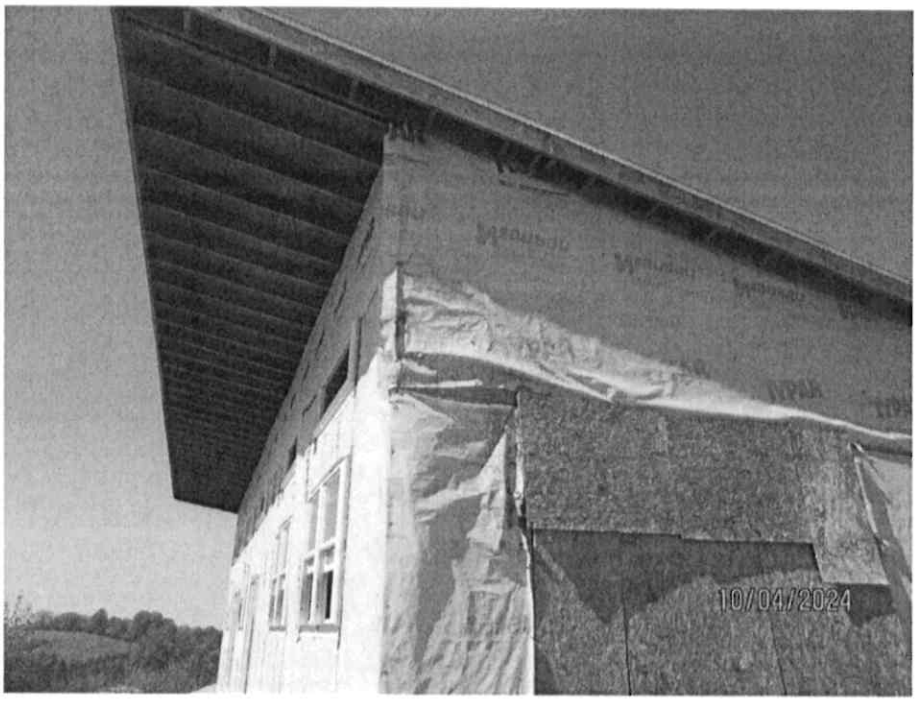

Photo 13: View of detached and displaced exterior WRB areas, as seen on the east elevation and southeast corner. See next photos.

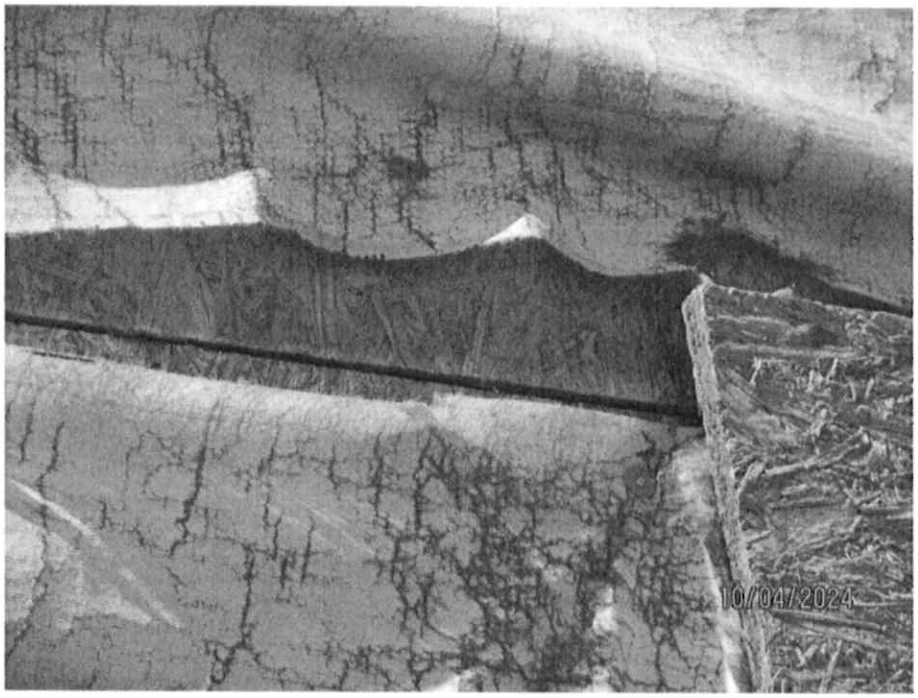

Photo 14: View showing tattered, frayed, detached WRB and water damage to OSB exterior wall sheathing to the south of the overhead garage door on east elevation.

Photo 15: Close-up view showing typical moisture damage to OSB wall sheathing at the tops of the overhead door openings on the east elevation.

Photo 16: View of tattered, frayed, detached WRB on the west elevation of the residence.

Photo 17: View of tattered, frayed, detached WRB on the south elevation of the residence.

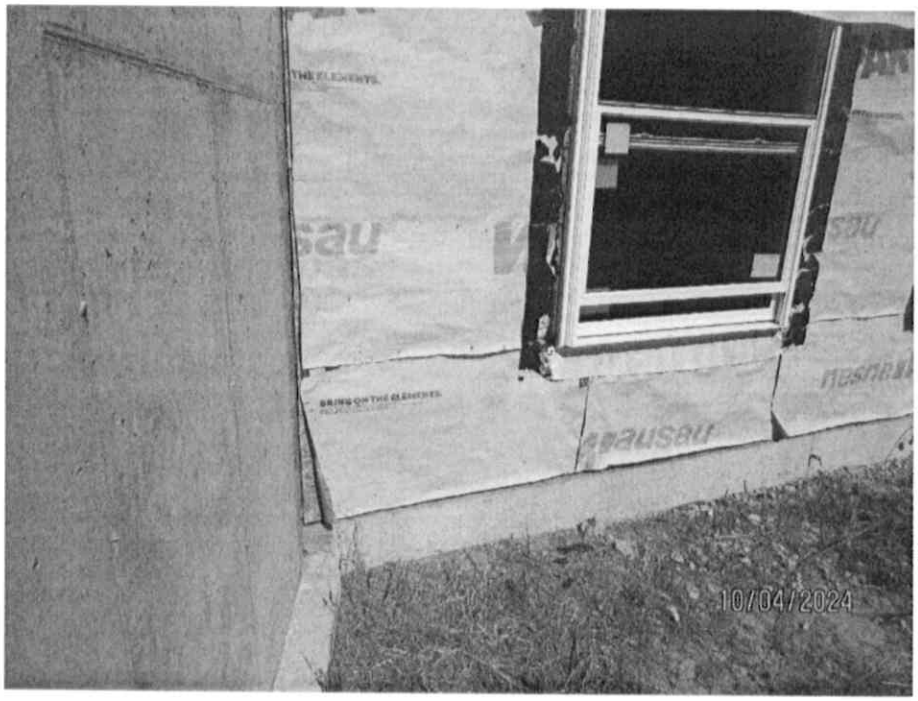

Photo 18: View of tattered, frayed, detached WRB on the south elevation of the residence. See also next photo.

Photo 19: View of moisture damage to OSB exterior wall sheathing at the base of wall at the west end of south elevation.